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TYPHOID FEVER AT MOLINE, ILLINOIS[1]

By M. C. Sjoblom

During the fall of 1917, reports received by the State Department of Public Health indicated that an unwarranted amount of typhoid fever existed in Moline. This state of affairs continued and the author was detailed to investigate it. A study of the conditions between September 1, 1917, and April 1, 1918, showed conclusively the source of infection to be city water. Recommendations were made for safeguarding the water supply against further infection. In July, 1918, the Department received reports indicating an explosive outbreak of typhoid. A second investigation showed conclusively that the city water supply was again the agent of infection. Following closely the main outbreak in July a small local outbreak occurred which was traced to water from a well, doubtless infected through near-by sewers.

Moline, a manufacturing city of somewhat over 30,000 population, is situated on Mississippi River. Moline, Rock Island, and East Moline comprise one community. Rock Island has a population about the same as Moline. East Moline has had a very rapid growth and probably has in the neighborhood of 8000 inhabitants. During the three years prior to the opening of the filter plant in 1902, the annual typhoid death rate of Moline was 100, 144, and 151 per 100,000; since then it has been 22 to 60, except in 1918, when it jumped to 80 in the first eight months.

The cases in the last outbreak were found in every part of the town. The general distribution of cases throughout Moline, as well as the fact that Rock Island and East Moline had but few cases and the majority of these gave histories of having received infection in Moline, pointed quite strongly from the beginning toward the water supply as the source of infection.

There was a preponderance of male cases, accounted for by war conditions causing local factories to offer attractive wages, bringing a large number of men to Moline for employment. The majority of these were young men without families.

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[1] Read before the Illinois Section on March 25, 1919.

The main factory district lies along Mississippi River. In order to receive minimum insurance rates from the underwriters, it has been necessary for the factory owners to provide two sources of supply for fire purposes. To meet this demand, what is known as the manufacturers' main has been laid between the factories and the river. This main is connected with the city supply. There were but few connections made originally, but as time went on additional connections were made, until 20 or more are now in use. The manufacturers' main is provided with single check valves near the points at which it is connected to the city mains. Single check valves are also provided on all cross-connections. By-passes equipped with small gate valves are placed at some of these points.

The check valves are installed to open toward the factory side of the connections, thus permitting the city water to enter the system, but tending to prevent a flow into the city mains should a breakdown or insufficient pressure in the city supply make it advisable or necessary for the factory pumps to be operated. The city pressure is ordinarily carried at about 110 pounds.

As now operated, the city supplies quantities of water to only a few factories. A number have their own pumps forcing river water into sections of the factory pipes, which are presumedly shut off from the city. However, the factories have fire pumps installed for emergency purposes and these are tested weekly or thereabouts to see that they are in good operating condition. Annual fire tests are also made, which in some cases are quite extensive, but during these periods all precautions are presumably taken to prevent the water from entering the city mains.

In the recent outbreak the attention of many of the citizens was at once centered on this factory water pipe arrangement. As a result, the city officials took it upon themselves to test out one or more of the connections to see if the check valves operated properly. Accordingly, one Sunday they closed the proper gate valves on the distribution system of the city which would permit water to enter a section of the city mains between these valves should the checks leak. It was stated that upon opening a hydrant in this section of pipe, the water came through the check with sufficient force to be thrown to the opposite side of the street. The valve here tested was one which had been installed for a large number of years and it was not at all surprising that it leaked badly. There is not a check valve made which can be depended upon to remain water-tight unless systematically cared for and it is safe to predict that had tests been made on all the checks the majority would have been found to leak.

Considerable sewage finds its way into the river at relatively short distances above the Moline water works. Some of these towns discharging sewage above Moline had more or less typhoid. For instance, Clinton, Iowa, about 35 miles upstream, had a number of cases during the fall of 1917 when Moline was also suffering from the disease. East Moline and Watertown Hospital, both of which had a number of cases of typhoid, discharge sewage about 5½ miles above the water works. In addition, a sewer serving the east end of Moline discharges above the intakes. Though these conditions do not prove the exact point from which the infection entered the river, they indicate the dangers with which Moline had to contend, and the need to operate the water-purification plant efficiently at all times. It is quite likely that the sewage from some of these points actually constituted the sources of the infection which entered the city mains and caused the typhoid.

During the outbreak of typhoid in the fall of 1917, the thickness of the filtering medium in the water treatment plant had been reduced about 10 inches below the original thickness. A large part of the underdrain system had become clogged, making it necessary to maintain excessive rates of filtration in portions of the bed in order to supply the demands of the city. With the low efficiency of the filters in this condition the quality of water was questionable. Ordinarily no bad result would have followed, as liquid chlorine was fed into the effluent as it passed to the clear wall, but the records showed that the chlorinator refused to operate on a number of occasions and as a result poorly filtered water was pumped into the mains. This may have been responsible for a number of infections. But the main number of cases doubtless resulted from another factor in the plant, a by-pass. This was not given due prominence during the first investigation, but information secured in a later investigation made it quite apparent that it played a major rôle in the typhoid infection.

Some years ago the commissioner of water works decided to make it possible to pass settled water into the clear well at such times as the demands were greater than the filter capacity. This often occurred after the strainers began to clog, and when the clear well, which had a very limited capacity, had been heavily drawn from. In order to carry out this idea a gate valve was placed in the pipe leading to the sewer from two wash troughs adjoining a wall common to two filters. By opening the valves leading from the troughs to this pipe and also opening the valve used if filtered water was to be wasted into the sewer, an open channel was provided through which the settled water passing over these two filters could enter the clear well. Then by closing what was known as the by-pass valve, which was installed below the point at which the waste line was connected with the sewer line, the water was forced to pass through the waste line into the clear well with the filtered water.

The records indicated some of the dates on which the by-pass was opened during the fall of 1917, but there is reason to believe that water had been by-passed on other occasions and that the chlorine had been off during the same period.

Following the outbreak in the fall and winter of 1917 and 1918 the city had all the filters overhauled, the defective strainers replaced, and better sand used. Orders were also given for two chlorinators to replace the machine which had for one reason or another given endless trouble. With the filters overhauled and the city alive to the dangers of permitting a partially treated water to enter the city mains, it was thought that no further trouble would be had. However, in July a sudden and serious outbreak of typhoid fever occurred.

This outbreak, like the preceding one, comprised cases scattered throughout the city. The same method of eliminating possible sources of infection was used as in the former investigation, with the result that all evidence pointed conclusively to the city water supply. With the filters newly overhauled, it was evident that the sudden and extensive outbreak could not have occurred from filtered water, even had no chlorine been added to the effluent. There was reason, therefore, to believe that the by-pass had been used.

The plant records showed that the old chlorinator had given considerable trouble and a new chlorinator had not been installed until July 1, which was after the infection must have occurred but, as before stated, this alone could not explain the cause of the outbreak. There still remains the possibility of the by-pass being opened, but the records showed no occasion where this had occurred which could be responsible for the main outbreak. The chemist was, therefore, questioned as to the possibility of the by-pass having been opened but not recorded. No instance was learned, the chemist stating that the filters in their existing condition were capable of yielding sufficient water for all needs and the by-pass had not been used. In spite of these denials, the evidence appeared so conclusive against the city plant that it was decided to simply remain at the plant on the theory that some one would eventually disclose some incident which would lead to a solution.

As expected the necessary information was secured from an employee. The chemist had opened the by-pass about 5 p.m. on June 21 and left it open until about 2 p.m. on June 22. During this period one of the sedimentation tanks had been cleaned, cutting the sedimentation period in two, which permitted water even poorer than usual to enter the clear well. A study of the records showed that the chlorine was on only a part of the time the water was being by-passed. Later information was secured from a diary kept by the chemist that the by-pass was also open during a part of June 19. During portions of this period little or no chlorine was being added. There is no doubt but that the typhoid outbreak in July resulted from the opening of the by-pass on the dates mentioned.

Measures were again taken to prevent any more infectious matter entering, but more cases were reported than should have resulted from secondary infections. It was soon found that the majority of these cases lived in a certain section of the city or else had been working or visiting near-by. A careful study made here indicated that a private well was responsible for a second outbreak in which perhaps 25 cases became infected. This well is of the dug type, approximately 75 feet in depth. About 72 feet of this depth is in limestone. The top of the well was adequately protected. The exact channel through which this well became infected is not definitely known, but there is every reason to believe that the sewage from an adjoining building which had contained some typhoid cases may have entered the well and caused the trouble, or that sewage from sewers in streets adjoining, which are laid in the limestone formation, may have travelled through a crevice in the rock to the well.

The conclusions to be drawn from these incidents are:

1. In a filter plant treating a polluted stream water by-passes should under no conditions be tolerated. This means that the plant must be of ample capacity to supply sufficient filtered water at all times.

2. Dual connections, such as exist at Moline, should not be permitted. Although in this case nothing indicated that the raw river water from the factory main entered the city supply, still a real danger exists under these conditions. Even should double checks be installed, the personal element in caring for these valves is a source of danger.

3. Records ought to be kept of all operations, even if there is danger from criticism being raised later relative to certain acts. Nothing will help more to reveal dangerous conditions than to note every operation, so that if some trouble arises the full records can later be studied. If this had been done at Moline, the cause of the outbreaks would have been very easily found. Often what appear to be trivial incidents to the average attendant may prove of great importance when studied in connection with other facts.

4. There is a real danger in using a water supply from a limestone formation and especially where the well is located near sewers or privies entering the limestone. Another case in Illinois has again brought out this fact.

DISCUSSION

H. E. Keeler: There is no question there was a typhoid outbreak at Moline, in fact the city chemist has, in his paper on the filtration plant, stated a second outbreak occurred. The thorough investigation made by the State Board of Health clearly showed that among other possible causes for the outbreak were the numerous connections between the mains of the city water service and the private fire supply services installed in large manufacturing plants which take their supply from the river close to the shore line and depend on keeping an impure supply from entering the city mains by the use of ordinary check valves, many of which were installed for a long time. The author referred to a test made on one of those connections which showed that the leakage was so great that water was thrown from a hydrant across the street showing that practically it was of no service as a tight valve. This may have been an isolated and aggravated case, but it showed what might happen to any such connection so made and connected by the use of the wrong type or an inefficient check valve. Therefore one of the conclusions in the paper is that the use of check valves would be unsafe.

This would be a good conclusion to arrive at, if it was a fact. The fact is, there are efficient and safe check valves made, designed for the purpose of preventing an impure supply getting into a pure city supply. The great necessity for such a device was brought out several years ago by reason of a typhoid epidemic that occurred in a prominent manufacturing city in the east. A careful investigation was made to ascertain the causes. Finally it was found that the city water supply was contaminated by impure water reaching the mains through fire service connections in several of the factories, which were not fitted with efficient, tight valves. The result was that the underwriters, health authorities, and several of the manufacturers of these appliances got together, and while the problem was a big one, it was solved and an appliance was designed, tested and approved by the underwriters, health authorities and the American Water Works Association. It has been successfully installed and, as far as the speaker knows, it has never failed to serve the purpose for which it was designed. This apparatus is made by several valve manufacturers. It consists of a specially designed, flanged, straight-way bronze-mounted check valve, with rubber-faced clappers and extra large clearances, designed to resist corrosion and to prevent derangement of the parts. They are installed in pairs and arranged with test valves and gauges so that they can be tested and inspected frequently for tightness and efficiency. They are usually tested quarterly, but of course can be tested more frequently if desired. By using such an apparatus, properly installed, the risk of danger from an impure supply is practically eliminated. Their cost is of course quite a bit higher than for regular or even underwriter check valves, but when human life is at stake, cost is quite a secondary consideration. The speaker has never known it to be considered by large manufacturing concerns which have occasion to meet such a situation.

A. E. Anderson: The typhoid rate, as stated by the author, has been high at times other than the mentioned epidemics, and as pointed out by him some 25 cases in the epidemic mentioned were due to a well in the western part of the city. This, and the fact that the city is fairly loaded down with privies and analyses of most well waters show them to be contaminated, is the reason for the speaker's opinion that this high rate may be largely attributable to wells and privies. In some cases the stools from typhoid patients have been dumped into these privies without any use of germicides and in other cases the germicidal material has been improperly used.

M. C. **Sjoblom**: If the contamination had come from leaky check valves, the epidemic would have been more local. The pressure in the city mains is usually about 110 pounds, while the pressure in the factory fire system is never raised much above 80 pounds, so that it would be only during a breakdown or drop in the city pressure that factory water could enter the city mains, even should the valves leak.

H. P. T. **Matte**: It is desirable to amend Mr. Keeler's statement regarding the use of a number of check valves by the Moline industrial plants. These will be installed as an additional safeguard only, because at all times pure city water is to be used in the factory lines. In cases of a conflagration, however, and if the city pumping plant should fail, the check valves will permit the factories to fight the fire with raw river water without contaminating the filtered water in the city mains. The industrial plants are willing to pay the price of the valves for an additional protection, both against fire and against disease.

W. W. **Deberard**: The fact that impressed the speaker was that after filtration was begun typhoid dropped down at times to 20 to 25, but that is still high. Mr. Anderson has given a good reason for that, namely, that there are a large number of wells in a poor state of repair and little attempt has been made at disinfection in typhoid cases.

C. K. **Calvert**: There is a protecting scheme to be had which any company can install on services of consumers who have an impure supply which may be forced back into the public mains. On the service line three valves may be placed, the middle one a check valve. Between it and each of the end valves a small tap in the main shows on inspection whether or not the check is operating. Inspections should be made very frequently, since failure to operate may produce serious results. This is an almost perfect protection.